

**AN ANALYSIS OF MOTH WINGS FOUND AT THE FEEDING PERCH OF A
BROWN LONG-EARED BAT *PLECOTUS AURITUS* (L.) (CHIROPTERA:
VESPERTILIONIDAE) IN BLUNTISHAM, CAMBRIDGESHIRE,
FROM 1980-1983**

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Abstract

The wing remains of a total of 2,039 moths were collected from underneath the feeding perch of a Brown Long-eared Bat during 1980-83. Approximately 96% of the moths were of the family Noctuidae. The majority of the moth species identified are widespread and common in suburban habitats and probably reflected local conditions. Fifty-six percent were of just four species: the Dotted Rustic *Rhyacia simulans* (Hufn.), the Mouse Moth *Amphipyra tragopoginis* (Cl.), the Common Rustic *Mesapamea secalis* agg. and the Stout Dart *Spaelotis ravida* (D. & S.). Of these, the Dotted Rustic was experiencing a population explosion in eastern England at the time of the survey and the Stout Dart had also been increasing in previous years. Both these species and the Mouse Moth, aestivate or roost in sheds, outbuildings, under bark etc. The predominance of these species in the prey is discussed and it is suggested that these bats may be able to locate and exploit collections of aestivating or roosting Lepidoptera. Comparisons are made with several other similar British surveys. Only six species were common to all surveys.

Introduction

The Brown Long-eared Bat *Plecotus auritus* (L.) is one of Britain's commonest and most widely distributed species of bat and feeds exclusively on insects and other arthropods (Swift & Racey, 1983; Stebbings, 1988; Shiel *et al.*, 1991). The bat belongs to a group known as gleaning bats, in that a substantial proportion of their diet is caught by "gleaning" prey items off vegetation, the ground or other substrate rather than by aerial hawking (Anderson & Racey, 1991; Shiel *et al.* 1991). The presence of deciduous woodland in the vicinity of the bats' roost sites is thought to be key as a foraging habitat (Swift & Racey, 1983; Entwistle *et al.*, 1996). Suburban situations where there are plenty of deciduous trees are presumably also suitable.

A much higher proportion of moths is found in the diet of many gleaners than in that of many bats that are primarily aerial hawkers (Rydell *et al.*, 1995). A substantial part of the Brown Long-eared Bat's diet consists of noctuid moths. However, studies involving the analysis of faecal pellets from the roosts of these bats have revealed that they eat a wide range of other invertebrates including flies, beetles, caddis flies, shield bugs, lacewings, centipedes, spiders, earwigs etc. (Swift & Racey, 1983; Rydell, 1989; Shiel *et al.*, 1991). Depending on the time of year and location, the bat's diet may be expected to include 20-70% moths though 20-40% appears to be more usual (Swift & Racey, 1983; Rydell, 1989; Rydell *et al.*, 1995; Shiel *et al.*, 1991). Moths may be favoured prey items, as when moths are most abundant (in July and August), they form a substantially higher proportion of the

bat's diet than other orders which are also more abundant in midsummer (Shiel *et al.*, 1991; Williams, 1939).

Many moths (and some other insects) have primitive ears, known as tympanic membranes. These tympanate moths include Noctuidae, Geometridae, Notodontidae and Pyralidae, but not the Hepialidae (Faure *et al.*, 1993; Fullard, 1987). Tympanate moths are best able to hear the echolocation sounds of bats within the range of 20 to 40 KHz (Faure *et al.* 1990; Rydell *et al.* 1995). Aerial-hawking bats tend to emit long, high intensity ultrasonic echolocation calls of relatively low frequency in order to locate prey accurately at a distance while flying. These calls tend to be within the optimum hearing range of tympanate moths (Faure *et al.*, 1993; Rydell *et al.*, 1995). On hearing an approaching bat's ultrasonic calls these moths will take evasive action. Tympanate moths are about 40% less likely to be caught by aerial-hawking bats than non-tympanate moths (Rydell *et al.*, 1995) and consequently many aerial-hawking bats feed mainly on insects other than moths (Rydell *et al.*, 1995).

Gleaning bats (sometimes called "whispering", "quiet" or "listening" bats) have relatively broad wings (for slow, hovering flight) and large ears (for listening for sound produced by their prey). More often than not they locate their prey by listening for prey-generated sounds, such as fluttering, and may approach and capture their prey in silence, i.e. without using echolocation at all (Anderson & Racey, 1991; Faure & Barclay, 1992). When they do use echolocation to capture prey they emit short, low intensity (faint), high frequency ultrasonic sounds which are both relatively quiet and outside the optimum hearing range of tympanate moths, thereby escaping detection (Faure *et al.*, 1990; Waters & Jones, 1995). A proportion of their prey, including moths, is also caught by aerial hawking.

The frequent presence of non-flying arthropods in the bat's diet (e.g. the report of centipede remains in faecal pellets in an Irish study by Shiel *et al.*, 1991), suggests that the bats may also be able to hear the pattering of tiny feet (all those legs may not be such a good idea after all!) or may detect the disturbance of litter over which the arthropods are crawling. Long-eared Bats also have relatively large eyes compared with other species of bat, so eyesight may be also be used for prey location

Hibernating or roosting Lepidoptera may also be eaten by Long-eared Bats. The remains of the Herald Moth *Scoliopteryx libatrix* (L.) and the Small Tortoiseshell butterfly *Aglais urticae* (L.) have been found under bat perches (Poulton, 1929; Roer, 1969; Thompson, 1982; Warne, 1985; Chris Hall *pers. comm.*). However at other times hibernating Lepidoptera are left untouched (Roeder & Fenton, 1973). It has been suggested that bats may also be able to locate their prey by smell (Roer, 1969). Chris Hall (*pers. comm.*) reports that a Brown Long-eared Bat would not approach closer than about 15 centimetres to proffered moths if they had been kept in a match box rather than a glass jar, suggesting that the bat could smell residual chemicals from the previously stored matches.

Large prey items (especially noctuid moths) are taken to temporary feeding perches to be consumed; small prey items are presumably eaten while the bat is in flight, or whole while the bat is perching. The location of these perches can be found by the presence of discarded insect remains (chiefly moth wings) and bat droppings

underneath the perch, particularly where the perches are situated in a place where there is little wind to blow the insect remains away.

In August 1980, EJ discovered a feeding perch of a long-eared bat in a 'built-in' car port, open to the south, adjoining a residential house in the village of Bluntisham, Cambridgeshire (in Huntingdonshire, vice county 31). The bat was presumed to be the Brown Long-eared Bat. The only other species of long-eared bat in Britain is the very rare Grey Long-eared Bat *Plecotus austriacus* (Stebbing, 1988). This has subsequently provided us with an opportunity to investigate the diet of the Brown Long-eared Bat with respect to larger moths, perhaps to shed some light on the feeding behaviour of the bat and on the abundance and behaviour of moths in the area, and to make some comparisons with other similar studies, notably those of Thompson (1982) and Howes (1996, unpublished study), and those detailed by Poulton (1929). The habitat surrounding the feeding perch consisted of suburban gardens (to the east and west), a large playing field with scattered lines of mature and younger deciduous broad-leaved trees (north), and an extensive orchard of plum, apple and pear less than 30 metres away to the south.

On 9 August 1983, a dead Brown Long-eared Bat (positively identified) was found, still clinging to the wall, at the feeding perch. Numbers of moth wings collected had been high for several days previous to this, and although numbers of wings found subsequently dropped markedly, wings continued to be deposited in the same corner of the car port until the end of September. This strongly suggests that at least two bats were using the feeding perch, at least for a time (Figure 2).

Methods

Remains of moth wings were collected daily in 1980 beneath the temporary feeding perch at Bluntisham, from 6 August until 6 September, after which no more moth wings appeared that year. Similar collections were made daily in 1981, 1982 and 1983 from under the same perch from the first day in each year that moth wings appeared until no more wings were found at the end of the summer. Business commitments, requiring EJ to spend time away from home, account for the lack of data in early September of some years. Daily collections were kept separate for later identification.

Moth species were subsequently identified from the wing remains, as far as possible by pairing up wings to avoid duplication, and tending to err on the side of caution. It is likely, therefore, that the numbers of moths identified are slightly underestimated.

At the time the moth wings in this study were identified in the early 1980s, the species now known as the Common Rustic *Mesapamea secalis* and the Lesser Common Rustic *Mesapamea didyma* were treated as one. In 1983, two species were formally recognised. Although the wing remains were retained, the two species cannot be reliably separated without examination of the genitalia and so, for the purposes of this study these two species have been lumped together.

Results

A total of 2,039 individual moths of 72 species was identified from wing remains collected at the Bluntisham bat perch between 1980 and 1983 (Table 1). In 1980, 93% of these were noctuid moths and in each of the following three years approximately 96% of the moths were noctuid moths making an overall average for the four years of 95.9% (Table 2). The remaining moths were a few representatives of the families Hepialidae, Pyralidae, Geometridae, Thyatiridae, Arctiidae and single representatives of the families Oecophoridae and Notodontidae.

In the years 1981, 1982 and 1983, 58%, 54% and 60% of the total moths comprised just four Noctuid species, namely the Dotted Rustic, the Stout Dart, the Common Rustic group and the Mouse Moth. The percentage each species made of the total in each of the three years and in 1980 is shown in Table 2.

Table 3 lists the 20 most frequent species (over the four years) at the Bluntisham feeding perch, and gives the percentage each made of the total catch in each year at Bluntisham. The table also shows a comparison with other surveys for those 20 species. Other datasets in the table are from Sheffield in 1921 (Poulton, 1929, but collected by Whitaker); Skelton in 1979 and 1980 (Thompson, 1982) and from Rossington near Doncaster in 1984 and 1991 (Howes, 1996, unpublished study). The survey entitled "1929 various" is a combination of a number of smaller surveys, individual details of which are given by Poulton (1929). These smaller datasets are from various British locations and dates (between 1905 and 1928) and as such are not strictly comparable with the other surveys, but they have been included here for interest.

Just six species of moth are common to all the surveys: the Large Yellow Underwing, the Lesser Yellow Underwing, the Heart and Dart, the Dark Arches, the Common Rustic and the Mouse Moth. The Large Yellow Underwing was always among the top three most frequent prey items in the earlier surveys, and at Rossington in 1991. However at Bluntisham it came out seventh overall, but second in the incomplete series of 1980. The Cabbage Moth *Mamestra brassicae* (L.) and the Silver Y *Autographa gamma* (L.) were also found more frequently overall at Bluntisham than the Large Yellow Underwing.

Figures 1-3 show the number of moths identified from the daily collections in the years 1981-83. In 1982, moth wings appeared somewhat earlier than in 1981 and 1983. The figures also show the number of Dotted Rustic, Stout Dart and Mouse Moth identified from daily collections, the differences in phenology of the three species being apparently reflected in the catches.

Discussion

Since the moth wings for this study were collected, a great deal more has become known about the feeding habits and diet of the Brown long-eared Bat, particularly from studies using captive bats and from studies involving the analysis of faeces from wild bats. It was previously thought that Brown Long-eared Bats fed predominantly on noctuid moths, whereas it has become clear that moths make up only between 20-40% of the bats' diet on average. At the height of summer, moths

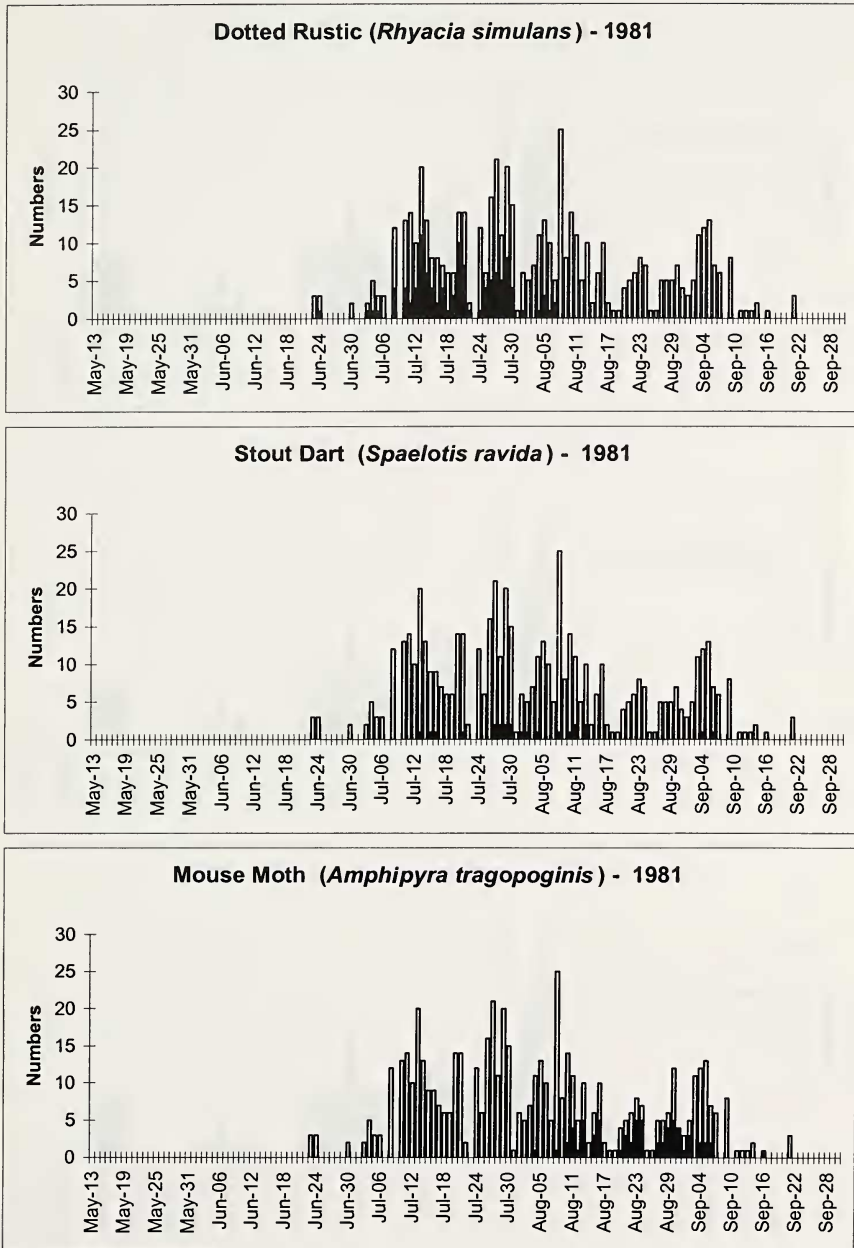


Figure 1. Total nos. of individual moths (wing remains) (clear + solid bar) and nos. of three species of noctuid moths (solid bar) collected daily in 1981 from under a feeding perch of a Brown Long-eared Bat in Bluntisham, Cambridgeshire.

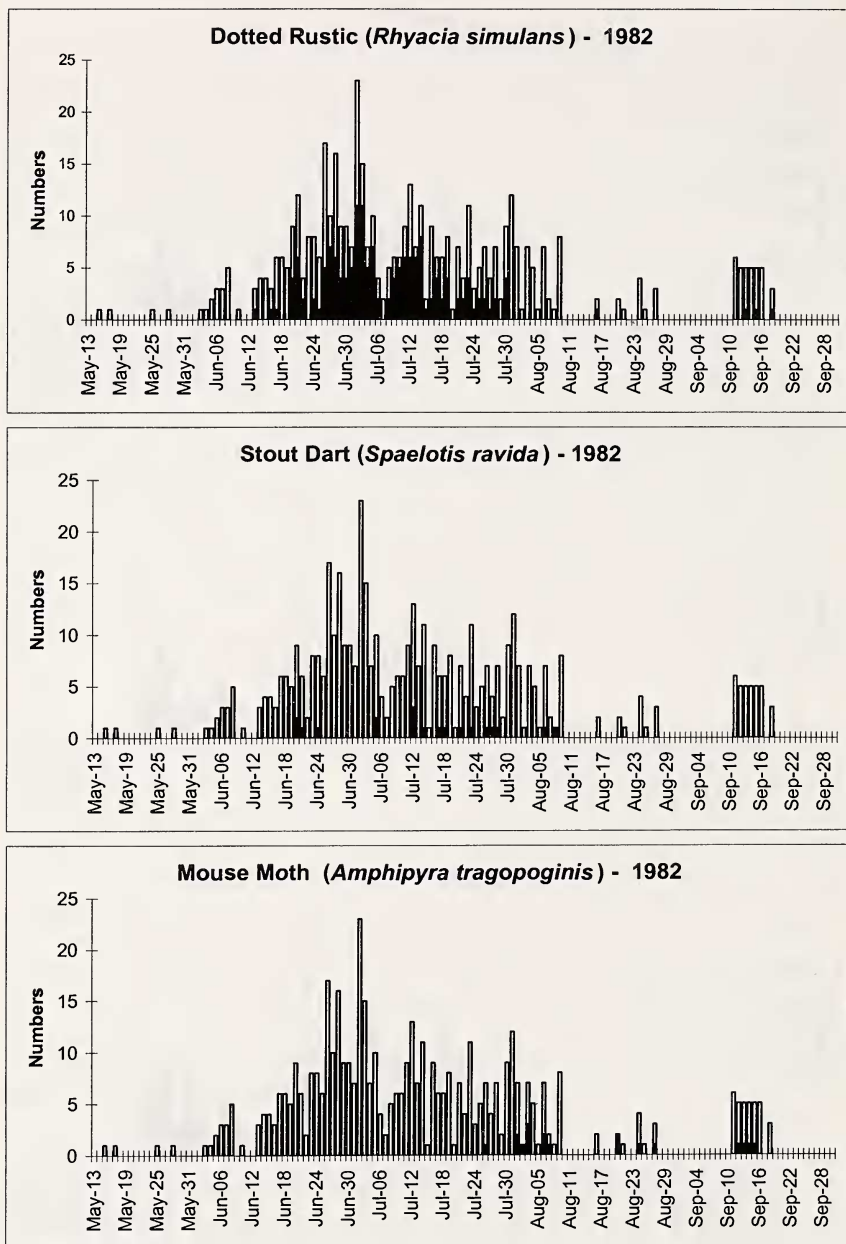


Figure 2. Total nos. of individual moths (wing remains) (clear + solid bars) and nos. of three species of noctuid moths (solid bar) collected daily in 1982 from under a feeding perch of a Brown Long-eared Bat in Bluntisham, Cambridgeshire.

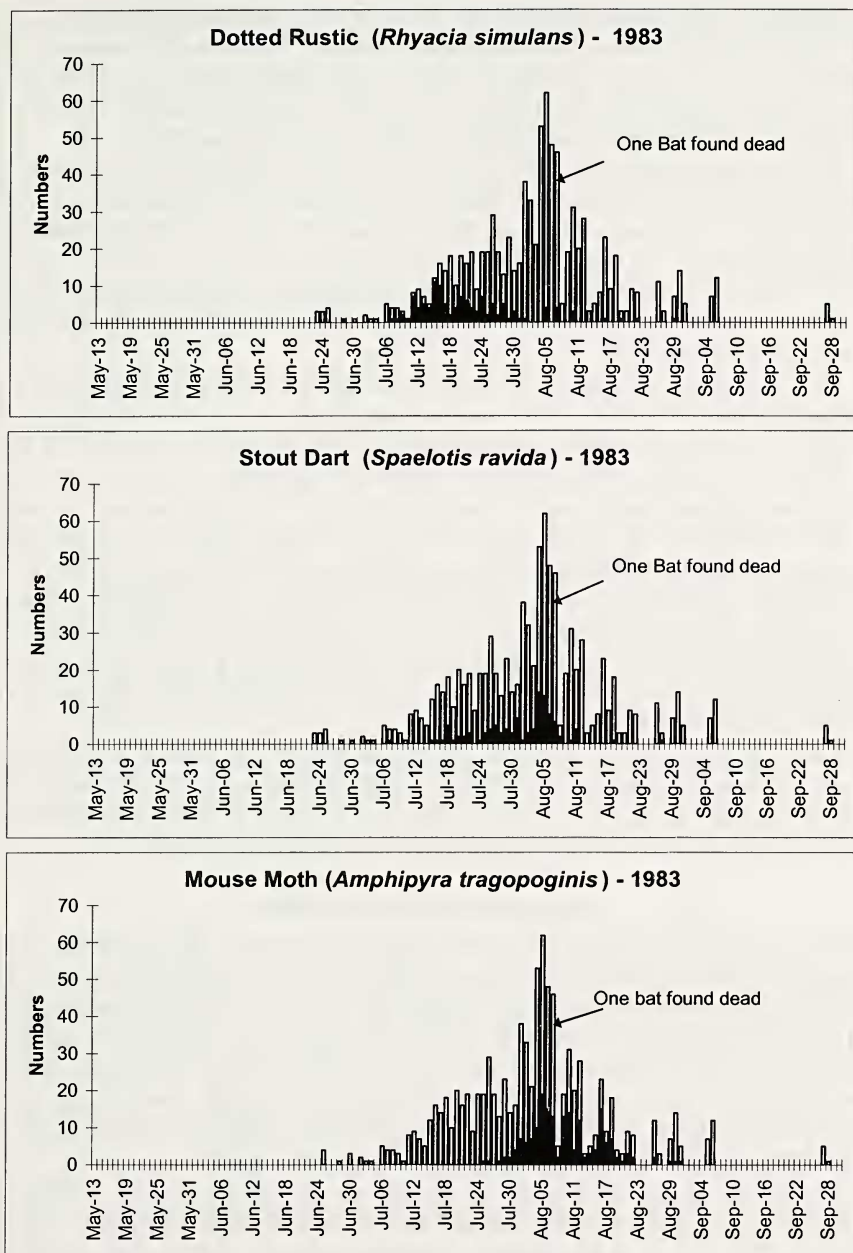


Figure 3. Total nos. of individual moths (wing remains) (clear + solid bar) and nos. of three species of noctuid moths (solid bar) collected daily in 1983 from under a feeding perch of a Brown Long-eared Bat in Bluntisham, Cambridgeshire.

may make up a higher proportion of the diet than this, suggesting that moths may be favoured prey items when they are readily available. In this study, discussion can therefore only focus on the larger moths, most smaller moths (including most Geometridae), along with arthropods of other orders, being presumed to have been consumed while the bat(s) was in flight or eaten whole while perching.

The very high proportion of noctuid moths (96%) identified from wing remains, compared with other families of moths, is consistent with expectations based on other surveys. This compares favourably with the 94% noctuids identified from the Skelton series in 1979 and 1980 (Thompson, 1982). At Sheffield in 1921 (Poulton, 1929), 98% of the 799 moths identified were Noctuidae. At Rossington the two series were made up of almost 100% Noctuidae, with the only other prey item being three Small Tortoiseshells.

Moths taken can be expected to reflect the habitat surrounding the roost of the bats and also reflect the habits of the moths themselves, i.e. their catchability (with respect to the bat), availability and palatability. So at Skelton, for example, the high proportion of Cabbage Moths (Table 3) reflected the presence of kitchen gardens in the vicinity of the feeding perch where brassicas were the predominant vegetable grown (Thompson, 1982). This species was also a frequent prey item at Bluntisham and again probably reflected the presence of brassicas in local vegetable plots. Most of the moth species found in this study therefore came as no surprise, being among the most common and frequently encountered species in suburban habitats in southern Britain and also among those most frequently taken at light traps in the area (Huntingdonshire, vice county 31) at the time of year that the bat was operating (Barry Dickerson *pers. comm.*).

The daily fluctuations in numbers of moths brought to the feeding perch is likely to reflect weather conditions on different nights; an analysis of the data with local meteorological data would probably confirm this. However if the bat uses more than one feeding perch, this may compound differences caused by weather.

Aestivating and roosting moths

Of the four most frequently found moths at the feeding perch, the abundance of the remains of the Dotted Rustic and the Stout Dart was certainly unexpected. The Dotted Rustic was not found in the samples of the earlier surveys referred to here (Table 3), however it did contribute to a very high proportion of the catch at Rossington in both 1984 and 1991, especially in 1984 (Table 3). This moth was also one of the species recorded by Warne (1985) at a bat feeding perch at Hilton in Derbyshire in 1984, but no numbers are given. The Stout Dart also occurred in significant numbers at Rossington in 1984.

The Dotted Rustic used to be considered as "nationally scarce" in Britain. However the appearance of the Dotted Rustic in the bat's diet corresponded with a population explosion of this species in eastern England, which started in the late 1970s (Waring, 1992). In fact the first county record for this species for the old county of Huntingdonshire was on 27 August 1979 (Scott, 1979). In 1980, a further 18 examples were recorded in Huntingdonshire, including the 9 found at the Brown

Table 1. Annual totals of moths (estimated from wing remains) collected from under a feeding perch of a Brown Long-eared Bat in Bluntisham, Cambridgeshire in the years 1980-1983.

Family	Sub-family	Species	Bradley no.	Species	1980	1981	1982	1983	Total
Hepialidae		Ghost Moth	14	<i>Hepialus humuli</i>		1	1	3	5
		Orange Swift	15	<i>Hepialus sylvina</i>		1	1	3	5
		Common Swift	17	<i>Hepialus lupulinus</i>	2	1	1		4
Oecophoridae	Depressariinae		715	<i>Agonopterix capreolella</i>		1			1
Pyralidae	Crambinae			<i>Crambus</i> spp.			2		2
			1304	<i>Agriphila stramineella</i>		1			1
			1305	<i>Agriphila tristella</i>	1	1		1	3
	Schoenobinae		1329	<i>Donacaula forficella</i>		1			1
	Pyraustinae	Small Magpie	1376	<i>Eurrhyncha hortulata</i>			1	11	12
		Mother of Pearl	1405	<i>Pleuropteryx ruralis</i>			1	1	2
	Pyralinae	Large Tabby	1421	<i>Aglossa pingualis</i>			2	2	4
	Galleriinae	Bee Moth	1428	<i>Aphomia sociella</i>		2	1	2	5
Thyatiridae	Thyatirinae	Buff Arches	1653	<i>Habrosyne pyritoides</i>		4	5	2	11
Geometridae	Sterrhinae	Small Blood-vein	1682	<i>Timandra comae</i>	1		1		2
		Riband Wave	1713	<i>Idaea aversata</i>	1			1	2
	Larentiinae	Garden Carpet	1728	<i>Xanthorhoe fluctuata</i>	1	3			4
		Yellow Shell	1742	<i>Campioptogramma bilineata</i>				1	1
		Dark Spinach	1749	<i>Pelurga comitata</i>	1				1
	Ennominae	Swallow-tailed Moth	1922	<i>Ourapteryx sambucaria</i>		1		1	2
		Willow Beauty	1937	<i>Peribatodes rhomboidaria</i>		3		7	10
Notodontidae	Phalerinae	Buff-tip	1994	<i>Phalera bucephala</i>	1				1
Arctidae	Arctiinae	Buff Ermine	2061	<i>Spilosoma luteum</i>	2	1			3
		Ruby Tiger	2064	<i>Phragmatobia fuliginosa</i>		1		1	2
Noctuidae	Noctuinae	Garden Dart	2082	<i>Euxoa nigricans</i>	14	7	3	21	45

Family	Sub-family	Species	Bradley no.	Species	1980	1981	1982	1983	Total
		Turnip Moth	2087	<i>Agrotis segetum</i>	1	7	25	10	43
		Heart and Dart	2089	<i>Agrotis exclamatoris</i>		5	24	10	39
		Dark Sword-grass	2091	<i>Agrotis ipsilon</i>		3	2	12	17
		Shuttle-shaped Dart	2092	<i>Agrotis puta</i>	2			7	9
		Flame	2098	<i>Axytia putris</i>				1	1
		Flame Shoulder	2102	<i>Ochroleura plecta</i>				9	9
		Dotted Rustic	2105	<i>Rhyacia simulans</i>	9	111	158	113	391
		Large Yellow Underwing	2107	<i>Noctua pronuba</i>	17	26	14	17	74
		Lesser Yellow Underwing	2109	<i>Noctua comes</i>	11	17	4	25	57
		Least Yellow Underwing	2112	<i>Noctua interjecta</i>		3	7	18	28
		Stout Dart	2113	<i>Spaelotis ravida</i>	3	23	19	106	151
		Ingrailed Clay	2120	<i>Diarsia mendica</i>				3	3
		Setaceous Hebrew Character	2126	<i>Xestia c-nigrum</i>	1	13	3	33	50
		Double Square-spot	2128	<i>Xestia triangulum</i>			1		1
		Square-spot Rustic	2134	<i>Xestia xanthographa</i>	1	4	2	8	15
	Hadeninae	The Nutmeg	2145	<i>Dicentra trifolii</i>		1	1	3	5
		Cabbage Moth	2154	<i>Manestra brassicae</i>	14	43	16	22	95
		Dot Moth	2155	<i>Melanchra persicariae</i>		6	1	2	9
		Bright-line Brown-eye	2160	<i>Lacanobia oleracea</i>	3	10	11	6	30
		Smoky Wainscot	2198	<i>Mythimna impura</i>	1	2	1	3	7
		Common Wainscot	2199	<i>Mythimna pallens</i>		2	2	4	8
	Cucullinae	Dark Brocade	2250	<i>Blepharitis adusta</i>			1		1
		Lunar Underwing	2270	<i>Omphalocelis lunosa</i>			1	1	2
		Orange Sallow	2271	<i>Xanthia citrigo</i>	1				1
	Acronictinae	Dark Dagger/Grey Dagger	2283/4	<i>Acronicta tridens/psi</i>	1		2		3
		Knot Grass	2289	<i>Acronicta rumicis</i>			1	1	2

Family	Sub-family	Species	Bradley no.	Species	1980	1981	1982	1983	Total
		Coronet	2291	<i>Craniophora ligustri</i>				1	1
	Amphipyriinae	Copper Underwing	2297	<i>Amphipyra pyramidea</i>	1	2			3
		Mouse Moth	2299	<i>Amphipyra tragopoginis</i>	24	67	19	177	287
		Straw Underwing	2303	<i>Thalpophila matura</i>	1	4		1	6
		Angle Shades	2306	<i>Phlogophora meticulosa</i>	1	26	23	22	72
		Dark Arches	2321	<i>Apamea monoglypha</i>	8	8	3	16	35
		Light Arches	2322	<i>Apamea lithoxyla</i>	1	1	7	2	11
		Large Nutmeg	2333	<i>Apamea anceps</i>		2	4		6
		Rustic Shoulder-knot	2334	<i>Apamea sordens</i>		1	5		6
		Marbled Minor	2337	<i>Oligia strigilis</i>		1	5		6
		Cloaked Minor	2341	<i>Mesoligia furuncula</i>		2			2
		Common Rustic	2343	<i>Mesapamea secalis</i> agg.	13	117	51	134	315
		Flounced Rustic	2353	<i>Luperina testacea</i>		1	1	1	3
		Rosy Rustic	2361	<i>Hydraecia micacea</i>		4			4
		The Uncertain	2381	<i>Hoplodrina alsines</i>	1	3	2		6
		Mottled Rustic	2387	<i>Caradrina morpheus</i>			1	1	1
		Pale Mottled Willow	2389	<i>Paradrina clavipalpis</i>		1	1	2	4
		unknown species	-	unknown species			1		1
	Plusinae	Burnished Brass	2434	<i>Diachrysia chryssitis</i>		1		1	2
		Silver Y	2441	<i>Autographa gamma</i>	4		12	63	79
		Spectacle	2450	<i>Abrastola tripartita</i>		1			1
	Catocalinae	Red Underwing	2452	<i>Catocala nupta</i>				1	1
	Ophiderinae	Herald	2469	<i>Scoliopteryx libatrix</i>	1	1	2	3	7
Totals:					144	548	452	895	2039
Number of species:									72

Long-eared Bat's feeding perch that year (Greatorex-Davies, 1981). The Stout Dart was also experiencing a time of relative plenty, Skinner (1984) states "...this species is now flourishing in many parts of southern, central and eastern England...".

Both these species emerge in late June and in July but can be found through to September or even October. Both aestivate for a time in refuges such as sheds, outhouses and other buildings, or under loose bark (Skinner, 1984). Dotted Rustics have been found aestivating together in numbers in outbuildings (Barry Dickerson *pers. comm.*).

Both the Dotted Rustic and the Stout Dart are caught in the Rothamsted light traps, but relatively infrequently. However, from those that have been caught it appears that the Dotted Rustic reached a peak in abundance between 1984 and 1988, whereas the Stout Dart seemed to peak between 1968 and 1978 (Ian Woiwod *pers. comm.*). Since then it appears that both species have declined.

The Mouse Moth emerges later than the preceding two species (as was reflected in the captures at Bluntisham, see Figures 1-3), but can also be found roosting together in numbers by day in similar situations. This moth is often abundant and occurs regularly in light traps. What is perhaps more interesting is that it is the most frequent species caught in the 12 metre Rothamsted suction traps, indicating that this species is a high flyer! (Ian Woiwod *pers. comm.*) (Taylor, 1974). The Mouse Moth was by far the most abundant moth caught in a Rothamsted suction trap at Cardington during August and September 1959 (Taylor & Carter, 1961). Greater than an order of magnitude more individuals (355) of this species was taken than the next most abundant species on that occasion, the Large Yellow Underwing (14), another apparent favourite of the Brown Long-eared Bat (Thompson, 1982).

The apparent selection of species that roost or aestivate in buildings etc. and under bark is intriguing. As has already been mentioned, Small Tortoiseshell butterflies are also sometimes included as prey items. Proportionately large numbers of Small Tortoiseshell wings (49 out of a sample of 128 forewings) were found at a Long-eared Bat perch in a church belfry in North Wales in late March 1995 (Chris Hall *pers. comm.*). Other species present (eg Large Yellow Underwing) indicated that at least some of the wing remains collected had been there since the previous summer. The Old Lady Moth (*Mormo maura*) (Linnaeus 1758) has also been found as a prey item on occasions (Poulton 1929; Chris Hall *pers. comm.*), including one in the porch of the church in Hemingford Grey, Huntingdonshire, in the summer of 1995. It may be that these bats are able to locate and exploit aestivating or roosting moths. Perhaps if one of a group of roosting moths flutters and is heard by a bat, the lives of the whole collection of hibernators are put in jeopardy. They can certainly readily locate and capture moving prey while on the ground (Poulton, 1929; Chris Hall *pers. comm.*), and these moths may roost in similar locations to the bats themselves, therefore becoming particularly vulnerable to predation. Swift & Racey (1983) found the remains of clothes moths (Tineidae) and blowflies (Calliphoridae) in faeces of Brown Long-eared Bats which were roosting in the attic of a large house. As both these types of insect commonly occur in such roof spaces, the authors suggest that the bats caught them inside the roost. Roer (1969) suggested that long-

Table 2. The percentage of the total number of moths identified from wing remains at the Bluntisham Brown Long-eared Bat feeding perch for the four most frequent moth species (all Noctuidae), remaining Noctuidae, other families and total Noctuidae for the years 1981-83.

Year:	1980	1981	1982	1983	1981-83	All years
Dotted Rustic <i>Rhyacia simulans</i>	6.3%	20.3%	35%	12.6%	20.2%	19.2%
Common Rustic <i>Mesapamea secalis</i> agg.	9%	21.4%	11.3%	15%	15.9%	15.4%
Mouse Moth <i>Amphipyra tragopoginis</i>	16.7%	12.2%	4.2%	19.8%	13.9%	14.1%
Stout Dart <i>Spaelotis ravida</i>	2.1%	4.2%	4.2%	11.8%	7.8%	7.4%
Other Noctuidae:	59%	38%	41.8%	36.8%	38.3%	39.8%
Other families:	6.9%	4%	3.5%	4%	3.9%	4.1%
Total Noctuidae:	93%	96%	96.5%	96%	96.1%	95.9%
Total numbers:	144	548	452	895	1805	2039

eared bats could locate stationary prey by smell, after finding that a captive bat confined in a cage with hibernating Herald Moths and Small Tortoiseshell butterflies would feed on them (quoted in Thompson, 1982).

However there may be other reasons for the predominance of these moths as prey items. For example, it could be the sheer abundance of the species concerned, or particular selection by the bat for these species from other situations (e.g. presence at honeydew, ability to identify from fluttering sounds or by smell), or some other unknown or unconsidered aspect of the moths' behaviour causing them to be particularly vulnerable to predation.

Aposematic moths

There is conflicting evidence as to whether some moths, notably the Arctiidae, are avoided by long-eared bats because they are distasteful. From this and the previous studies examined here, it would appear that arctiids are mostly avoided. Only two species of Arctiid were among the prey items identified at Bluntisham, the Buff Ermine *Spilosoma luteum* (Hufn.) (three specimens) and the Ruby Tiger *Phragmatobia fuliginosa* (L.) (two specimens). Arctiids were also found in other studies (Poulton, 1929; Thompson, 1982), but, as here, in low numbers and nearly all were the Buff Ermine. However two White Ermine *Spilosoma lubricipeda* (L.) were included in one of the series detailed by Poulton (1929). The Buff Ermine emerges slightly later and, having a lower level of toxins than the White Ermine, is likely to be less distasteful to the bat.

Table 3. Comparisons between different British surveys: the percentage of the total number of moths identified from Brown Long-eared Bat feeding perches at various sites in different years for the 19 most frequent species identified (overall) at Bluntisham, listed in order of abundance. Data for Sheffield and "various" are taken from Poulton 1929; Skelton: Thompson 1982; and Rossington: Howes 1996.
P = present, but in very low numbers; - = not recorded; blank square = data unavailable.

Year:	1921	1929	1979	1980	1980	1981	1982	1983	1984	1991
	Sheffield	Various	Skelton (York)	Skelton	Bluntisham	Bluntisham	Bluntisham	Bluntisham	Rossington (Doncaster)	Rossington
Total no. of moths in sample:	799	529	160	809	144	548	452	895	48	149
	%	%	%	%	%	%	%	%	%	%
Dotted Rustic <i>Rhyacia simulans</i>	-	-	-	-	6.3	20.3	35.0	12.6	67.0	29.5
Common Rustic <i>Mesapamea secalis</i> agg.	9.9	5.5	5.6	9.8	9.0	21.4	11.3	15.0	-	0.7
Mouse Moth <i>Amphipyra tragopoginis</i>	4.9	8.3	1.9	-	16.7	12.2	4.2	19.8	13.0	6.0
Stout Dart <i>Spaelotis ravida</i>	-	-	-	-	2.1	4.2	4.2	11.8	6.0	-
Cabbage Moth <i>Manesira brassicae</i>	5.3	4.0	20.6	9.8	9.7	7.8	3.5	2.5	-	-
Silver Y <i>Autographa gamma</i>	1.1	4.2	10.0	18.0	2.8	-	2.6	7.0	-	-
Large Yellow Underwing <i>Noctua pronuba</i>	22.9	33.3	16.8	29.2	11.8	4.7	3.1	1.9	2.0	20.8
Angle Shades <i>Phlogophora meticulosa</i>	0.6	1.1		p	0.7	4.7	5.1	2.5	-	-
Lesser Yellow Underwing <i>Noctua comes</i>	6.5	7.4	26.8	10.9	7.6	3.1	0.9	2.8	2.0	12.1

Year:	1921 Sheffield	1929 Various	1979 Skelton (York)	1980 Skelton	1980 Bluntisham	1981 Bluntisham	1982 Bluntisham	1983 Bluntisham	1984 Rossington (Doncaster)	1991 Rossington
Setaceous Hebrew Character <i>Xestia c-nigrum</i>	-	0.4	-	-	0.7	2.4	0.7	3.7	-	-
Garden Dart <i>Euxoa nigricans</i>	-	0.9	-	-	9.7	1.3	0.7	2.3	-	-
Turnip Moth <i>Agrotis segetum</i>	0.9	1.3	-	-	0.7	1.3	5.5	1.1	-	2.7
Heart and Dart <i>Agrotis exclamatoris</i>	0.4	1.1		p	-	0.9	5.3	1.1	-	3.3
Dark Arches <i>Apamea monoglypha</i>	26.4	13.4	6.9	6.7	5.6	1.5	0.7	1.8	6.0	13.4
Bright-line Brown-eye <i>Lacanobia oleracea</i>	0.3	1.1	-	1.4	2.1	1.8	2.4	0.7	-	-
Least Yellow Underwing <i>Noctua interjecta</i>	-	-	-	-	-	0.5	1.5	2.0	-	-
Dark Sword-grass <i>Agrotis ipsilon</i>	-	0.8	-	-	-	0.5	0.4	1.3	-	-
Square-spot Rustic <i>Xestia xanthographa</i>	0.6	0.2	-	-	0.7	0.7	0.4	0.9	-	0.7
Small Magpie <i>Eurrhynx hortulata</i>					-	-	0.2	1.2	-	-
Buff Arches <i>Habrosyne pyritoides</i>	-	-		0.1	-	0.7	1.1	0.2	-	-

At the Skelton feeding perch in 1979 a single specimen of the Garden Tiger moth *Arctia caja* (L.) was found (Thompson, 1982). The moth was untouched except for tooth marks deeply embedded in its thorax, suggesting that the moth was dropped in disgust!

In contrast to the above, on 17 June 2002, Martin Corley (*pers. comm.*) found mostly arctiid remains at a long-eared bat's feeding perch on his farm in Oxfordshire. At the perch he found the wing remains of at least 25 Buff Ermines and seven White Ermines. The only other moth remains he found at the perch were those of six Ghost Moths *Hepialus humuli* (L.) and one Large Yellow Underwing. This bat at least seemed to like these arctiids.

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